BY ORDER OF THE COMMANDER
AIR FORCE MATERIEL COMMAND

AIR FORCE MANUAL 91-201

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Safety

EXPLOSIVES SAFETY STANDARDS

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The term "center" applies to laboratories, operating locations (OL), wings and other subordinate activities of a center. This supplement applies to Air National Guard and US Air Force Reserve units and members operating at Air Force Materiel Command (AFMC) facilities or on AFMC bases.

SUMMARY OF REVISIONS

A requirement to contact this HQ concerning any request for SECAF determination for storage of non-DoD hazardous items has been added. A requirement to contact this HQ for hazard classification guidance has been added. Additional operational risk management (ORM) clarification was added in two paragraphs. An address change for Hill AFB has been added. A requirement to forward classification procedures for locally manufactured explosives is added. A requirement to include a map in the simulator activation lesson plan and a requirement that explosive ordnance disposal (EOD) coordinate lesson plans with safety is added. A requirement to have simulator activation barriers approved by the base fire officials is added. Storage or manufacturing residue and scrape is clarified. Technical order (TO) was added to the tech data requirement. A requirement to coordinate with the safety office concerning the use of barrier has been added. A reminder that scrape material may also have to be processed as hazardous waste was added. A requirement to store and maintain egress type equipment in separate locations is added. The exemption for DoD personnel handling honor guard duties, shooting teams etc. was expanded. A requirement for units to maintain records of carbon monoxide checks is added. Clarification was added for what to do when explosives are received without tech data. A requirement to use the standardized command cover letter was added. The Civil Engineer/facility user requirement was changed to an "and/or" requirement. Renumbering has occurred to align the supplement with the basic.

AFMAN 91-201, 7 March 00, is supplemented as follows:

1.2.3.8. One copy of the documentation of the periodic (every five years) review results, will be forwarded to HQ AFMC/SEW.

1.3.2. Forward request through HQ AFMC/SEW. HQ AFMC/SEW will forward to JA for additional coordination.

1.3.3. Contact HQ AFMC/SEW for classification assistance.

1.4.2. Forward two copies of all site plans and procedures for deploying units to HQ AFMC/SEW.

An ORM assessment must be accomplished for all locally written OIs for new operations and changes to existing operations that involve explosives prior to beginning any explosives operations. The assessment must be used as a guide in developing locally written OI's and safety briefings to ensure each approved risk mitigation measure is implemented. This analysis and assessment provision is not intended to include that portion of the operations covered by approved Air ForceTOs.

2.3.5. Forward one copy to HQ AFMC/SEW for approval.

2.8.2. Only the minimum quantity of commercial explosives or munitions items will be purchased to support laboratory R&D operations. Emergency request for explosive or munitions items will be forwarded through HQ AFMC/SEW. The project officer of the laboratory requesting the explosives or munitions will obtain the hazard classification and other technical data required for the storage, handling/transportation, disposition, or maintenance of any locally purchased items. Excess items will be disposed of according to the applicable Environmental Protection Agency (EPA) approved methods described in the disposition instructions. Purchases are coordinated with the local acquisition management of hazardous materials and the safety representative. The 846th Test Squadron will be considered as an R&D activity.

2.10.1.2. Explosive residue and scrap from the manufacture of explosives will be stored as class/division 1.1L unless there is a current interim hazard classification and items are stored in appropriate closed containers.

2.13. Hunting area maps and procedures will be coordinated with and reviewed by the base weapons safety office.

2.15.1. If units, other than Air Force units, are using Air Force property, contact the major command (MAJCOM) for guidance concerning the use of training munitions other than that listed in Air Force stock list. HC (White) smoke producing devices will not be used for exercises.

Lesson plans used by munitions personnel to train others in the activation of simulators and smoke producing munitions will be coordinated with EOD, safety, and contain as a minimum a map showing authorized locations and safety distances, storage, handling, transportation, emergency, preparation, activation, dud procedures, and EOD notification procedures. At installations where EOD is conducting the training, EOD must develop a lesson plan containing all the elements described above and coordinate it through the safety office on the installation where the training is to take place.

2.15.4. The decision to use, or not to use barriers, will be determined locally in coordination with the installation safety office. If barriers are used they must be heat resistant and approved by the base fire officials.

2.15.5. The decision to use, or not to use barriers, will be determined locally in coordination with the installation safety office. Light metal containers of any type, i.e., 55 gallon drums, are not authorized for use as barriers when initiating ground burst or hand grenade simulators. A hole in the ground, sandbags or bias ply tractor tires (tires not containing steel belts) are authorized for use as barriers. Use of barriers does not reduce initiating distance contained in the basic AFMAN 91-201, paragraph 2.15.3.

2.16. All units conducting training or exercises will account for all munitions taken to the training area. Expended munitions will be recovered and properly disposed of according to TO 11A-1-60, *Inspection of Reusable Munitions Containers and Scrap Material Generated from Items Exposed to, or containing*

Explosives, immediately after training or exercises are concluded. Only areas specifically identified and authorized for training or exercises will be used.

2.26.1. Organizations contracting for the development or testing of explosives, propellants, complete explosive items or obtaining explosive items from other sources (Army, Navy, contractor, etc.) will ensure a current DoD explosive hazard classification has been assigned before any explosives items are transported or stored on base. If the procured explosive items do not have a DoD hazard classification, the procuring agency (laboratory or the using activities) provides the information required by TO 11A-1-47, *Explosive Hazard Classification Procedures*, to obtain an interim explosive hazard classification. Organizations manufacturing explosives, propellants or complete explosive items will also ensure a current DoD explosive hazard classification has been assigned before the explosives are transported or stored on base. To obtain a final explosive hazard classification, send request in six copies to OO-ALC/WMCS, 6034 Dogwood Ave, Hill AFB UT 84056-5816. Programs located at or being directly supported by AAC will send all requests for interim explosive hazard classifications to AAC/SES 1001 N. Second St., Ste 366, Eglin AFB FL 32542-6838. Interim hazard classifications are valid for one year and must be reviewed to determine if the need for the interim hazard classification is necessary. The review must be accomplished before the expiration date shown on the interim hazard classification letter is reached. Interim hazard classifications should only be issued once. If additional time is required, a letter of explanation must be forwarded to OO-ALC/WMCS along with the request for the interim hazard classification. Final explosive hazard classifications will be processed by OO-ALC/WMCS. Information format necessary to obtain a final explosive hazard classification is available in TO 11A-1-47.

2.26.1.2. Do not issue or ship items without a hazard classification. If an item is received without a current hazard classification, the receiving organization will contact the responsible agency, in writing, informing them of the needed explosive hazard classification. Shippers will receive a Report of Discrepancy (ROD). The notification action will be accomplished within 10 days of receipt of the item. If an approved interim hazard classification is not received at the unit within 30 days of receipt of the item from the procuring agency, HQ AFMC/SEW will be notified so assistance obtaining the explosive hazard classification can be provided. If no explosive hazard classification can be obtained within 60 days, the item or items will be identified for further disposition. The originator/procuring agency will be notified in writing of the planned disposition.

2.26.1.4. (Added) Explosives received for which there is no approved technical order or locally approved tech data describing storage, handling and inspection criteria will be placed in condition code 1.1L and will be reported for further disposition. Explosives received without technical data but with a known hazard classification may be stored as classified. Follow the same procedures as outlined for items received without a hazard classification for those items received without technical data. (See para 2.26.1.2.)

2.26.2. Send request to use empty munitions facilities for storage of firearms to HQ AFMC/SEW, HQ AFMC/DRRW and HQ AFMC/SFO. A coordinated response will be returned to the requester.

2.26.4. In the event the need arises to carry “in use,” ammunition into base facilities, the local weapons safety office will be consulted to determine if personnel safety can be maintained prior to such entry. This restriction does not apply to security or EOD units responding to real world threats. Exercises will be handled as outlined in AFMAN 91-201, paragraph 2-16.

2.26.5.4. Procedures for classification of locally manufactured explosives will be forwarded to HQ AFMC/SEW for review prior to their use.

2.27.9. The facility custodian makes sure the ventilator checks are performed and that the checks are documented. Checks will be accomplished as needed, but at least annually.

2.28.4. If the requirement for outdoor storage exceeds 30 days contact HQ AFMC/SEW for approval of the storage method.

2.31.1. Solid propellant residue or scrap from milling or dissection operations will be stored in separate magazines from other ammunition and explosives. Compatibility and quantity distance requirements from the AFMAN 91-201 apply to mixing scrap propellant in storage. This material may require treatment as hazardous waste and should be stored and handed IAW with the appropriate environmental standards.

2.31.3. Identify (tag) according to 00-20 series TOs.

2.37.4.1. Ejection seats, canopies, and explosives components not undergoing immediate maintenance will be stored in a separate location other than within the maintenance area. Ejection seats and canopies may only be stored in the maintenance area if all explosive components have been removed and placed in storage at a separate location.

2.37.5.1. Jammed gun clearing procedures will be reviewed by the local and/or contingency weapons safety personnel before being implemented.

2.37.8. Do not exceed 50,000 rounds total of all types of small arms ammunition.

2.46. Previously sited facilities that were built and used as Class 1 Division 1 locations, but are no longer used at that level, and are not by definition, a “hazardous location,” can be electrically repaired and maintained as Class 1 Division 2.

2.59. See this supplement paragraph 2.26.4.

2.62. Contact HQ AFMC/SEW for clarification.

2.64.3. Contact HQ AFMC/SEW for mixing approval.

2.64.4. If EOD cannot be contacted to determine the safety condition of dangerously unserviceable munitions, HQ AFMC/SEW will be contacted for assistance.

2.69. Center/wing safety personnel will coordinate with transportation and disaster preparedness personnel to determine if the base is listed in the Terminal Facilities Guide as a SAFE HAVEN/REFUGE site. Units will ensure all necessary preparations are accomplished prior to the need, and will meet all requirements for SAFE HAVEN/REFUGE.

2.70. DoD employees will not use privately owned vehicles to transport government explosives. The requirements of paragraph 2.71 do not apply to base shooting teams or honor guard detail transporting limited quantities of small arms ammunition in support of sanctioned events. For instance, base rifle, pistol teams, honor guard detail or OSI agents traveling in civilian vehicles but using DoD supplied ammunition would be exempt.

2.71. See para 2.70 of this supplement.

2.71.10. The using unit will request this check during initial operations in a facility. Maintain a record of this check.

2.75. Transport dangerously unserviceable munitions in a separate vehicle when possible or segregate and sandbag from other explosives being transported. Dangerously unserviceable munitions will not be transported in the same vehicle with demolition materials. (See this supplement, paragraph 2.64.4)

2.80. The following guidance applies to all explosive testing operations:

- Devices to be connected to electrical power sources for test or function of explosives or munitions will have power switches or activation devices locked out or held by supervisors during test set up.
- Power switch or activation device terminals are not located in test bays without adequate shielding.
- AFMC units, except AFFTC, ASC, AFRL, AEDC, AAC and OO-ALC, will not conduct munitions testing, disassembly, or modification other than that authorized by TO or time compliance technical order (TCTO) without prior approval of HQ AFMC/SEW or the item manager. No AFMC units, with the exception of the 846th Test Squadron, will be permitted to modify any stocklisted or non stocklisted munitions or explosives item (previously approved by the Nonnuclear Munitions Safety Board), without prior approval of the item manager. All requests for approval will include drawings, sketches, OIs and test plans. All procedures will be evaluated by installation weapons safety manager before testing begins.
- AFMC EOD units, except Det 63 AAC, Indian Head, MD, will not disassemble or modify stocklisted munitions without prior written coordination of the base Weapons Safety office, HQ AFMC/SEW, and HQ AFMC/CEPR. AAC EOD units may disassemble or modify foreign ordnance and test munitions utilizing approved written procedures coordinated through AAC/SEOW. All coordination packages will include drawings, sketches, OIs, and test plans.

2.81. OIs used for conducting test will include step-by-step procedures, warnings and cautions. Operational Risk Management (ORM) must be part of OI development and dry runs are done using inert munitions or simulated munitions to meet weight and configuration requirements. If live munitions must be used, HQ AFMC/CC approval must be obtained prior to use.

2.81.2.2. When there is no SPO or item manager, contact HQ AFMC/SEW for additional guidance.

2.82. MIL-STD-398 test plans are done when operations require personnel shielding. Test plans are reviewed by base weapons safety manager, and approved at HQ AFMC/SEW prior to implementation of the plan.

2.83. Contact HQ AFSC/SEW in writing through HQ AFMC/SEW.

3.2.1.1. The base civil engineer and/or the facility user performs the commanders review of the land uses to ensure it remains open, uninhabited and unused. Notify HQ AFMC/SEW through the local safety office concerning land use changes.

3.4. See this supplement, paras 2.26.1 and 2.26.1.2.

3.11.5. Contact HQ AFMC/SEW for further guidance.

Table 3.3, Note 43. Use K21/30 unless fragment considerations dictate greater distance; K21/30 is used for class 1 division 1 munitions only.

3.23.3. Mixed storage is not authorized.

3.25.6. If necessary to meet contingencies contact HQ AFMC/SEW for flare exemption.

3.30.5. See this supplement, paragraph 2.26.1.

Table 3.19, Note 2. Units concerned will submit substantiated recommendations to HQ AFMC/SEW, together with, or in the same manner as, site plans for new facilities under AFMAN 91-201, Chapter 4.

3.35.4. Contact HQ AFMC/SEW for further guidance.

3.36.4. Units wanting to use different configurations or buffer materials must submit definitive drawings through HQ AFMC/SEW.

4.1. Center/base weapons safety personnel will be members of, or at least attend, all Facility Planning Committee or other planning group meetings, to ensure projects having explosive safety implications are properly reviewed prior to the start of building/construction projects or modifications to facilities that may be effected by the proximity of explosive clear zones.

4.2. An example of the required information needed for the successful review of a base level potential explosion site (PES) or an exposed site (ES) site plan cover letter is located at attachment 1.

4.3.2. When a tenant facility, or area, is within the IBD of a host proposed siting, the host safety office will obtain agreement from the tenant and the tenant MAJCOM before forwarding the site plan to HQ AFMC/SEW for processing. If the affected MAJCOM will not coordinate the site plan from the base level, the base safety office will provide HQ AFMC/SEW with names and phone numbers of the appropriate MAJCOM representatives to be contacted.

4.3.3. Send site plan package in triplicate or an electronic copy to HQ AFMC/SEW for command review and approval. All sitings must be reconciled with the base comprehensive plan before being sent to HQ AFMC/SEW. If an explosive site is no longer needed HQ AFMC/SEW will be notified in writing to cancel the site plan. HQ AFMC/SEW will notify HQ AFSC/SE.

4.3.4. Send site plan packages in triplicate or an electronic copy to HQ AFMC/SEW for command review and approval. Send one additional copy if the site plan involves biological and chemical fillers, liquid propellants, toxic gases, sonic hazard areas, any form of electromagnetic radiation affecting health (including radioactive sources and microwave generators) and industrial x-ray. Send site plans before or at the same time as the Requirements Document and Project Management Plan (RAMP).

4.3.5. Construction will not be started without an approved DDESB site plan.

4.7.1. Modifications of facilities not covered by a waiver or exemption will be approved at HQ AFMC/SEW.

4.8.1. The format for MAJCOM approved site plans will be: one copy of the AF Form 943, Explosives Safety Site Plan, appropriately annotated, one copy of a clear map, scale at 1- 400 and a cover letter to describe the actual siting objective.

4.8.2. Contractor-owned/contractor-operated site plans will be reviewed at the request of a procuring contracting officer (PCO) by center/wing level safety office personnel, for compliance with explosive safety standards. Approval or disapproval authority is not within the purview of safety office personnel. Site plans will be returned to the PCO with recommendations for approval/disapproval. Air Force-owned/contractor-operated site plans will be routed through normal Air Force channels to the DoD Explosives Safety Board (DDESB) for final approval.

4.10.1. Tiered site plans will be forwarded through HQ AFMC/SEW for coordination prior to implementation.

4.11. Approval to use facilities not meeting the glass standard must be obtained through HQ AFMC/ SEW.

4.11.4.5. It is not necessary to wait until the entire Explosive Site Plan (ESP), project drawings and specifications are 100% complete to request final approval. Only those drawings and specifications dealing with explosives safety, environmental and security must be 100% complete and may be submitted at any time prior to the 100% design review. The ESP package must also include any assessment of analysis affecting the safety of the project.

Table 4.1, Note 5. See this supplement Table 3.3, Note 43.

4.18.2. Forward results of technical analysis to HQ AFMC/SEW for review and approval prior to using an alternative electric static dissipating method.

4.30.2. The number of gates needed for a new or modified explosives area will be determined during the facility design phase of any proposed construction project(s).

5.1. All requests for waivers and exemptions will be supported by engineering or Operational Risk Management analysis and a complete summary of all attempted corrective actions that could not be used to eliminate the need for the exception.

5.2.3.1. FAX a copy to AFMC/SEW.

5.2.5. Two copies of deviation requests will be forwarded to HQ AFMC/SE for review. Approval/disapproval will be by the MAJCOM commander or the commander's designated representative.

5.3.1. Three copies of all request will be forwarded through HQ AFMC/SEW to AFMC/CC. Two copies, if approved, will be forward to HQ AFSC/SEW for review and possible approval. A forth package may be needed if the request is to be forwarded for consideration by the SAF.

5.3.2. All deviations will be approved by AFMC/CC.

5.5.3. Units will use the format outlined from para 5.5.3.1 to para 5.5.3.8 for SAF exception approval request.

6.5.1. The affected unit will develop procedures to safely remediate those formerly used defense sites (FUDS) containing ammunition, explosives or chemical agents. Remediation plans will be provided to HQ AFMC/SEW for review and approval. Priority will be given to the remediation of sites which pose an immediate public risk.

6.5.4. If significant hazards arise during any phase of the remediation process contact HQ AFMC/SEW. This process also applies to easements.

6.8.3.2. Contact HQ AFMC/SEW for assistance.

6.8.3.4. Submit plans to HQ AFMC/SEW in triplicate.

6.8.3.5. Submit Certificate of Clearance to HQ AFMC/SEW in triplicate.

7.6. Notify HQ AFMC/SEW within 24 hours. HQ AFMC/SEW will notify HQ AFSC/SEW.

Chapter 8 (Added)

SPECIAL CRITERIA FOR MANUFACTURING, LOADING, RESEARCH, DEVELOPMENT, AND TESTING OF EXPLOSIVES

8.1. General Information. This chapter states safety requirements for the manufacturing, loading, research, development, and testing of explosives. These are in addition to other requirements in this manual.

8.2. Building and Construction. Follow the guidance in AFMAN 91-201 and DoD 6055.9- STD, *DoD Ammunition and Explosions Safety Standards*, enforcing policy in buildings where explosives are manufactured or processed.

8.3. Protective Clothing and Equipment . Follow the instructions in AFOSH Standard 91- 31, *Personal Protective Equipment*. Protecting workers from industrial hazards and preventing explosives contamination to the body and areas outside of the explosives operating area require special clothing and equipment.

- Workers who must wear protective clothing must be provided with showers or wash areas (suitable to the hazard) and space in a clear area for street clothes storage. Supervisors must make sure that workers are aware of and maintain proper safety habits and health standards.
- Work clothing must be suitable to the task and hazard involved.
- Garments and head coverings should be made from tightly woven, smooth fabric. They should fit snugly around the waist, wrist, and neck but should not be so tight that they irritate the skin or cause dermatitis.
- Garments must use nonmetallic fasteners and be easily removable. Pockets should be of the lattice type. Trouser or slack legs should be tapered, without cuffs, and should extend over the top of shoes or boots. Sleeves should be tapered and without cuffs.
- Goggles and eye shields must comply with AFOSH Standard 91- 31. They must not be made of nitrocellulose or any highly flammable material.
- Sweatbands should be worn to prevent perspiration from falling on materials susceptible to ignition by moisture.
- Hair should be covered and restrained to prevent contamination or entanglement with machinery.

8.3.1. Operational Shields. Operational shields and related remote controlled devices will be used where required to protect personnel and materiel. Protection is needed from potential hazards such as explosion, fragments, fire, pressure rupture of cases, and high velocity, high temperature gas streams from thrust units.

- The requirement for shielding varies with the circumstances of the operation. The commander or plant manager must determine the requirement based on a thorough technical analysis of each situation.
- Shields are usually not required in typical operations. This includes storage, shipping, handling, or authorized maintenance involving standard serviceable explosive items being provided to Air Force units. Refer to the TO covering the specific operation.

- Shielding is required in certain manufacturing, assembly, disassembly, testing, renovation, or disposal activities where significant hazards exist. If the hazard justifies, remote control equipment and closed circuit television should be provided.
- Suitable shielding may require steel plates, reinforced concrete walls, or shelters such as "dug-outs." The design and location of the shielding and shelters would depend on the quantity and type of explosives being processed.
- Some suppressive shielding techniques are available which can vent gases and shock waves. These can greatly reduce damage to structures and prevent the release of fragments.
- Multiple deflection panels can be built into a suppressive shielding door to retain most of the fragments. Also, concrete or armor plate can be used at strategic locations to retain large or high-speed fragments. This technique makes it possible to design operating facilities (particularly with smaller explosive charges) that permit reduced separation distances (the basic AFMAN 91-201, para 3.22).
- Some operating facilities have three walls and a roof that will withstand the force of the explosion without creating secondary fragments due to spalling. Use inhabited building distance for the open or frangible wall in a 60-degree arc on each side of the centerline from the mouth of the facility.
- The sides and rear of this facility may be part of a laboratory building. However, there must be a buffer zone or a second substantial dividing wall between the laboratory and other nonrelated areas.
- In the absence of reliable data, the adequacy of proposed shielding must be proven by actual tests before use. The tests should use quantities that are 25 percent greater as a safety factor. Tests may be done only by AFMC or by an agency approved (or delegated) by them. (See paragraph 2. 82 of this supplement). Weapons safety process managers determine shielding needs for local operations not covered by Air Force TOs. Pull-a-part operations on 20 mm and larger ammunition require a personnel protective shield unless they are conducted remotely. Operational shielding or remote processing is used on fuze assembly or disassembly into items such as 20 mm, 25 mm, and 30 mm ammunition. HQ AFMC will review the plans before the tests are done.

8.4. Quantity-Distance (Q-D) Requirements. Facilities for the manufacturing or processing of explosives must be planned and built to conform to the latest safety requirements. This also applies to temporary facilities.

8.4.1. Separation of Operations and Buildings:

- Manufacturing and processing will be done in a special area whose boundary is separated from all other areas by inhabited building distance.
- Personnel exposed to remotely controlled operations (including control stations for operations provided with blast-attenuating and fragment-defeating shields) shall be provided with fragment and public traffic route (PTR) equivalent protection (2.3 psi).

NOTES:

This protection is required from all remotely controlled operations to all exposures with people normally sited at K18.

- When several manufacturing or processing operations are located in the same building, individual hazardous operations will be separated from each other and from all nonhazardous operations. Where operationally feasible, intraline distance separation should be provided between each hazardous operation. Give as much additional protection as possible in separating operations and minimizing the results of any accident. Requirements for remote controls and personnel protection in specific propellant processing operations are in Table 8.1 of this supplement.
- The required separation between buildings (sites, pads, or other such locations) which forms a single production or operating line is as follows:
- Between two buildings containing explosives: intraline distance based on the building requiring the greater distance (except as listed below).
- Between an explosives building and a building in which nonexplosives line operations are done: intraline distance based on the amount of the explosives in the building
- Between an explosives service magazine and individual operating line buildings being served: intraline distance based on the explosives in the service magazine as a minimum.
- Between a curing facility and the individual operating line buildings being served: intraline distance based on the explosives in the curing facility as a minimum.
- Between an operating building and a normally uninhabited nonexplosives facility (such as paint and solvent storage) serving a single operating building: at least 50 feet. Intraline distance (if greater) is preferred.
- A nitroglycerin processing line may be treated as a part of a propellant processing line. Also, nitrocellulose operations preceding the mixing with nitroglycerin may be treated as a part of a propellant manufacturing line. The nitroglycerin and the nitrocellulose lines, therefore, may be located at intraline distance from the propellant manufacturing line and from each other. In future construction, the three types of lines should form a "Y."
- Operating lines will be separated by a minimum of intraline distance. This distance is based on the explosives in the line requiring the greater separation.
- Explosives batch mixing operations will be done in separate buildings or bays used exclusively for that purpose as follows:
- Large mixing operations will be located in separate buildings
- Small mixers should be in separate buildings. however, they may be located with other operations if the mixer is in a separate bay which is located between substantial dividing walls (or barricades). It must have enough operational shielding to protect the other operations.
- When the hazard classification of an explosive has not been established (TO 1lA- 1- 47), the explosive during site and construction planning should be classified as follows:
- As the most hazardous class division that might possibly apply during the stages of processing.
- As a class division 1.1 explosives, if a lesser upper limit (classification) of the possible range of the hazard cannot be clearly supported.
- Explosives Safety Distance for the Separation of Solid Propellant Manufacturing or Processing Operations. Some solid propellants assigned to class/division 1.3 will react as class/division 1.1 propellants during manufacturing and processing.

- These operational steps will be separated from other operations by the Q-D limitations of class/division 1.1. Class/division 1.3 propellants will use DoD 6055.9 STD table 9-10.
- Each step of the process must be reviewed and the potentially mass-detonating phases handled as class/division 1.1 propellant (basic AFMAN 91- 201).
- If a fire occurs when stored in confined packaging or unvented shipping containers or rooms, some class/division 1.3 propellants may detonate.
- Explosives Hazard Classification for Solid Propellant Manufacturing and Processing. (See TO 11A-1-47 for storage and transportation test procedures). Before operations begin, determine the chemical and physical properties of the materials and their explosives hazard classification. Do this for each phase of processing, considering the condition or environment during the phase. Such determination is necessary to ensure the use of proper safety principles and explosives safety distances.
- If there are no reliable data on the hazard for an operation, use TO 11A-1-47 testing procedures for the required tests. Testing must cover ignition, unconfined burning, thermal stability, and sensitivity to detonation under the condition or environment. If the material produces (sustains) a detonation under such conditions, treat it as a class division 1.1 explosive during that step of the process. This applies if it can produce a detonation either directly or indirectly through transition from a deflagration.
- Minimum testing may satisfy the classification requirements for several process positions. For example, for castable solid propellants:
- If reliable data indicates that the propellant mixing operations are class/division 1.1, no testing would be needed to adopt this classification.
- If testing shows that the uncured propellant will detonate, the casting and curing operations must be considered as producing class/division 1.1 hazards.
- If detonation tests show that the cured propellant will detonate, all operations must be considered as producing class/division 1.1 hazards.
- Tests may be done only by AFMC or by an agency approved (or delegated) by them. Send results of such testing to OO-ALC/LIWS 6043 Elm Lane Hill AFB UT 84056-5819. OO-ALC will forward the results to HQ AFSC/SEWV. This reporting requirement is exempt from licensing according to AFI 37-124, *The Information Collections and Reports Management Program, Controlling Internal, Public, and Interagency Air Force Information Collections*, paragraph 2.11.10.

Table 8.1. Remote Control Requirements for Certain Propellant Processing.

Operation (1)	Remote Control (2)
Blending and screening of ammonium perchlorates	Advisory
Blending and screening of perchlorates other than ammonium	Mandatory
Grinding and mechanized drying of perchlorates	Mandatory
Grinding, blending, screening and mechanized drying of ammonium nitrate	Advisory
Propellant mixing	Mandatory
Cutting, machining, sawing, planning, drilling, or other unconfined operations involving large quantities (over 15 lbs) of propellant	Mandatory
Cutting, machining, sawing, planning, drilling, or other unconfined operations involving small quantities (15 lbs or less) of Q- D class/division 1.3 propellants	Advisory
Pressing, extruding, or other confined operations	Mandatory
Casting propellants (3)	Advisory

NOTES:

(1) For personnel protection see para 7.3.

(2) Personnel exposed to remotely controlled operations including those as control stations) must be protected from air blast over pressure greater than 2.3 psi (K24) and from hazardous fragments.

(3) Where cast cure and finishing operations are conducted in pits below grade, class/division 1.3 distances may be used.

8.5. Castable Propellants:

8.5.1. Weighing, Measuring, and Handling Raw Materials. Scales for weighing raw materials will be electrically grounded, where needed, to properly protect the operation. Such grounds will have an equivalent current-carrying capacity not less than that of a No. 8 (0.128 inch) copper wire. This grounding is especially important where ammonium perchlorate and highly combustible materials are involved. Make sure that oxidizing agents are completely separated from combustible material, including metallic powders.

- At least two separate weighing or measuring rooms, properly equipped and identified, will be provided. The separate spaces will be used exclusively for the designated purposes.
- Vessels, sieves, and other equipment should be marked to designate the type of material with which they are to be used. They will be used only for that purpose.
- The designated use of spaces and equipment will not be changed without a thorough cleaning and inspection to make sure that all traces of the previous material have been removed.

8.5.2. Oxidizer Processing:

8.5.2.1. General Information:

- Avoid contaminating an oxidizer agent with any metal or chemical which may result in a more sensitive composition. Exposure time, temperature, and moisture will govern the location or degree of using of metals and chemicals which will sensitize the oxidizer.
- If possible, use closed systems or facilities to eliminate dust and contamination from outside sources.
- Fabricate flexible connections (socks) in pipes or duct systems which convey oxidizer materials of fire retardant, conductive materials. These materials must be chemically compatible with the oxidizers to which they will be exposed. The pipes and duct systems will be made electrically continuous. Flanged pipe connections are preferred.

8.5.3. Drying Oxidizer Agents:

- The safe temperature for drying each material will be established and will not be exceeded at any point in the drying apparatus or drying room. Dryers or ovens used to "dry, age, temper or condition" explosives or propellants have redundant, fail-safe temperature controls. These controls are function-tested annually.
- Records will be maintained to indicate test results. They will be stored at a location where they cannot be destroyed if the ovens fail.
- Thermostatic controls will be used to prevent the maximum safe temperature from being exceeded in the drying apparatus or drying room. Install temperature recorders to keep a continuous and permanent record of all essential temperatures.
- Dust should be held to a minimum in drying rooms.

8.5.4. Screening Oxidizers. When screening for process purposes, the screening equipment will be constructed so oxidizer material is not subjected to pinching, friction, or impact as a result of metal-to-metal contact. Rooms in which screening units are operated will be thoroughly cleaned daily, or more often if necessary, to eliminate hazardous accumulations of dust.

8.5.5. Blending Oxidizers:

- When gases are released during blending of oxidizer batches, a suitable means of relieving the pressure will be designed into the blender.
- The blender will be electrically bonded throughout.

8.5.6. Grinding Oxidizers:

- When impact-type mills are used, there must be enough clearance between stationary and moving parts to prevent metal-to-metal contact. Clearances will be checked as often as needed to ensure they are adequate. Operating the mill in an empty condition is only one way of detecting gross improper clearances. This method should not completely replace more refined methods in the schedule of preventive maintenance services.
- Oxidizer material will be passed through a screen mesh with openings no greater than the clearance between hammer and plate. Screen mesh size for ammonium nitrate should be the smallest that allows free flow of the pills.

- Use only compatible lubricants in perchlorate grinding equipment. Do not use organic solvents to clean such equipment.
- Determine the cleaning cycle and method for all grinding equipment and include in OIs.
- Provide grinding operations with wet dust-collection systems.

8.5.7. Preparation of Fuel Composition. Establish compatibility of materials. Incorporate controls to preclude mixing materials at a time or in a manner that would create sensitive compositions or hazardous conditions before processing

- When nitrators, washers, and other machines are equipped with mechanical agitators (because of the hazards in the process or the possibility that the process material will decompose), they should have at least two means of agitation. Each one should operate from an independent source of power to maintain the action in event of a failure. A means of preventing any unfavorable exothermic reaction must be provided.
- The processing of toxic and flammable materials and nitration involves explosion, fire, and toxic hazards, in addition to the hazards of acid handling. Efficient ventilating systems are required. Nitration buildings must have adequate exits and safety appliances (such as suitable neutralizing solutions and emergency showers) where needed. Personnel should also be given proper acid resistant or protective clothing and equipment where needed.
- The formation and accumulation of dust should be minimized in all preparation operations.

8.6. Mixing of Fuel Compositions and Oxidizers (Batch Method):

- Introduce oxidizer material into the mixer in a way that will minimize the formation of dust. It should protect against the uncontrolled discharge of static electricity.
- To prevent extraneous material from entering the mixes, use such devices as magnetic separators or fluoroscopes. This may occur when dry solids cannot be screened before they are charged into the mixer or introduced in a slay form.
- Before and after use, inspect blades and other moving parts of new mixers and like replacement parts for old mixers. Periodically, as specified by TO, owners manual, or other locally established schedule, inspect (magnaflux or x-ray) for cracks, crevices, and other flaws. Clearances between agitator blades and mixer bowls must be checked often enough to make sure the clearance is adequate. Keep a record of these checks, mixer blade adjustments, and any damage to the mixer blades and bowls. Records are kept where they will not be damaged if a mishap occurs.
- In an emergency (such as breaking a mixer blade during mixing), use extreme care in removing the propellant because metal fragments may be present. In such cases, add a compatible liquid to form a slurry so the propellant may be removed easily from the mixer.
- When consistent with the process system and requirements, place a noncombustible cover over the mixer bowl after charging operations are completed. This is to prevent the accidental introduction of foreign objects into the mixer.
- This cover should be lightweight metal or screen with mesh no greater than the minimum clearance of the mixer blades. The cover will be secured to the mixer housing in such a way that gases or vapors evolved during the mixing operation will not be confined.
- Hoppers and other means for charging mixers will not add to the confinement that inherently exists in such mixers. A properly designed closed system is acceptable. A system may be necessary to prevent loss of solvents, generation of unsafe solvent or toxic concentrations, or contamination.

- Avoid spilling or splashing a propellant during discharge of mixers. Take special precautions in removing the propellant from the mixer (undue force could cause ignition).
- Use only nonsparking devices to scrape down the sides and blades of mixers. Set up controls to prevent these and other devices from being accidentally introduced into the mixer.
- At the end of the cycle, inspect the inside of the mixer.
- When ammonium nitrate propellants are mixed using a ram and hydraulically operated lid, install a vacuum at or similar device for rapid ram and mixer lid withdrawal.
- Provide means for removing hazardous concentrations of flammable vapors, gases, fumes, and dusts for the mixing room.
- Position operators for discharge operations so that they will have a direct, unblocked route of rapid exit in an emergency.
- Interlock electric service to propellant mixers with fire protection system controls so that the mixer cannot work when the fire protection system is inoperative. Mixers will be electrically grounded, bonded, and tested. (See the basic AFMAN 91-201 Chapter 2 and AFOSH Standard 91-11).
- Secure hardware on mixers, monorail systems, or in other locations where it could loosen and fall into a mixer to prevent such an occurrence.
- Do not allow objects in the operating area (such as jewelry, pens, and coins) that may accidentally be introduced into mixers.
- Account for all loose tools and equipment before starting mixing operations. Locate shadow boards and other such racks or boxes in a separate or protected location away from the immediate area of the mixing operation.

8.7. Casting Propellant:

- Ensure pressurized casting vessels are capable of withstanding at least twice the maximum allowable working pressure. At least every 6 months these vessels must be given a hydrostatic test at 1-1/2 times the working pressure. At 5-year intervals and after any mishandling or dropping, these vessels will be hydrostatically tested at two times the working pressure. Keep a record of each test for each vessel and keep the records in a separate location.
- Design casting vessel assemblies to avoid internal cracks, crevices, corners, and pockets. Avoid any internal mating configurations which could cause propellant in a thin film to be pinched or rubbed.
- Secure lids on these vessels so that they will withstand the rated pressures.
- Ensure the line pressure for pressurizing the casting vessel does not exceed the working pressure of the vessel. Install filters in gas lines to remove water and oil.
- Equip each vessel with a blowout disk designed to blow out at 120 percent of the vessel's maximum allowable working pressure. The design will allow for the release of the potential rapid rise of pressure in the vessel when the propellant ignites. (Exception: This device is not required where it could serve no safety purpose. For example, in processing materials that detonate so rapidly that a blowout device would be useless in reducing the force of an explosion.)
- Provide means to prevent the casting vessel from moving when the blowout disk ruptures.
- Design valves through which uncured propellant flows to prevent propellant from being compressed between two metal surfaces (such as rubber diaphragm-type valves). Clean and inspect

these valves at regular intervals and keep a log of these inspections. Interconnecting piping used to convey explosive material will be of the flange joint connecting type.

- When casting is to be done by pump, install a rupture section both at the inlet and discharge sides of the pump. Design these rupture sections to relieve pressure in case of fire in the pump.
- When mandrels are inserted mechanically, design the equipment to prevent metal- to-metal contact between the mandrel and the motor case below the propellant surface.
- When pumps are used, provide workers at the propellant casting station with adequate protection. If the transfer vessel and pump are at the propellant casting station, casting will be done remotely by workers who are suitably protected from the exposure.

8.8. Block and Extrusion. Block presses may be used as required:

- Press ram flashing grooves and vacuum ports should be visually inspected after each forming cycle and cleaned, if necessary.
- In some cases, insufficient air escape from the mix before full pressure is applied to the press may cause mix deflagration or detonation. If enough air cannot escape, vacuum pumps will be used to evacuate air during the pressing operation.
- Vacuum lines should be flanged construction to allow ready access for periodic inspection and cleaning.
- Each press should be equipped with suitable positive safety devices (such as hardwood safety blocks) to prevent movement of the ram during loading operations.
- Final extrusion of propellant grains must be performed by remote control. Do not allow workers in the bay during extrusion.
- Cutoff of extruded propellant to grain size should be done automatically during the extrusion cycle. The guillotine method is preferable.
- For a manual cutoff, the wire loop method must be used. No more than two persons will be allowed in the bay during a manual cutoff.

8.9. Grain Contouring and Finishing. Power-driven equipment used for propellant trimming, facing, chamfering, and other cutting operations will be remotely controlled. Exception: This does not apply to operations involving ammonium nitrate or small quantities (15 pounds or less of other propellants). Provide dust collection systems for machine cutting operations. If drilling operations are needed, apply the protection arrangements in Table 8-1 of this supplement. Where hand trimming operations are needed, the following protection is required:

- Limit each bay to one motor or segment.
- Separate or protect bays from each other. (See paragraph 8.4.1 of this supplement).
- Equip each bay with a deluge system for fire protection. The system will use both hand operated and automatic tripping devices.
- Use only safety-approved trimming tools.
- Limit personnel to the minimum number required.

8.10. Propellant Curing:

- Establish the safe temperature for curing the propellant. Install dual independent heat controls to prevent that temperature from being exceeded. Dual controls are designed so the only failure mode is to a safe position (fail safe).
- Design heating units or elements so that they never touch the propellant.
- Handle or secure loaded motor cases or casting molds so that they cannot overturn.
- Provide a means of pressure relief on closed pressurized vessels into which motors are placed for curing.
- Design mold supports and other casting and curing fixtures so that they do not rub or pinch thin layers of propellant between metal surfaces.
- Raise or suspend loaded or partially loaded rocket motors at minimum distances above floor level. If tests or experience show that rocket motors may ignite upon dropping, take steps to reduce the risk of dropping.

8.11. Motor Finishing and Assembly:

8.11.1. General Information:

- If undue force is required to "breakaway" the mandrel, exert it through remote control.
- If a risk of ignition and propulsion exists during work on cured propellant in a pressurized vessel or rocket motor case, use antipropulsion devices. They must withstand the maximum pos sible thrust of the item at that particular point in the manufacturing or assembly process.
- When a motor case has internal threads, take steps to prevent contaminating the threads with the propellant. Casting and curing assemblies and fixtures should not have any internal threads, cracks, and crevices where propellant could be deposited. Disassemble them remotely and protect the workers with adequate shielding. Clean and inspect all threads before assembling component parts. If there is any risk of contaminating the propellant, threaded components should be assembled and disassembled remotely by properly shielded workers.

8.11.2. Machining of Case-Bonded Propellant:

- Case-bonded propellant may be cut, drilled, or otherwise machined in a vertical or horizontal position. The most desirable position from both the safety and operational viewpoint will be best determined and incorporated in an OI.
- In designing the machining area and equipment:
- Take into account the severe hazards of finely divided propellant.
- Provide protection for personnel by remote control.
- Provide capability of minimizing damage in event of an incident.
- Design equipment so that cutting tools or blades do not touch motor cases and other metal objects, do not generate excessive heat, and can easily be cleaned of dust and chips.
- Remove finely divided propellant and propellant dust by either the continuous wash or the vacuum collection system. Where vacuum is used, the wet- type is preferred, with the intake point as close as possible to the cutter blade.
- Waste products may be immersed in a stream of water flowing away from the operation and collected at a point outside the operating room or cubicle.

- If this cannot be done, they may be collected in a dry state at the operation. In calculating safety distances and total weight, use the explosives weight of waste collected plus that of processed and unprocessed motors in the operation.
- Perform drilling of rejected motors or other methods of reclaiming the propellant motor case in a separate location. Protect workers by operational shields or distance.

8.11.3. Machining Noncase-Bonded Propellant. If propellant grains are not case-bonded, they should be machined to the extent needed before they are loaded into motors. Also, observe the requirements listed above.

8.11.4. Igniter Insertion. When the motor is designed so that the igniter must be inserted in the manufacturing line, these requirements apply:

- The supply of igniters at the insertion station will be the minimum consistent with a safe and efficient operation.
- If the process requires removing the shorting clip, the igniter will remain shorted until immediately before insertion. Igniter will remain nonshorted for only the minimum time required for the operation.
- Process storage facilities (normally vented to the atmosphere) should be designed to provide safety from the effects of an incident involving all stored igniters.
- Means for grounding personnel must be provided for controlled dissipation of static electric charges during igniter insertion.
- Electrical continuity or other tests on igniters installed in rocket motors must be performed in a separate facility or other safely isolated location. Use operator shielding and remote controls to ensure protection if accidental ignition of the material or operation would create a hazard. During such tests, secure motors with propulsive features.

8.12. Reworking. Separate and shield loaded component disassembly operations from other operations. Common facilities may be used for assembly and disassembly if these operations are not done at the same time.

- Defective loaded components will be reworked only by trained workers under the direction of supervisors who know all of the hazards in both operations. The design of the item should be studied to find the maximum amount of force allowable for safe disassembly.
- After rigid inspection, disassembled components may be collected and fed back into the normal assembly flow if their condition allows normal assembly.
- Suitable protection for operators must be provided when the disassembly operation involves pyrotechnic-type igniters.

8.13. Double-Base Solventless Propellants:

8.13.1. Preheating Units. Heating units may be needed to preheat and soften powder so that it is plastic enough to be handled safely in hazardous mechanical work.

- If possible, the preheating units should be in rooms apart from other operations. These units should have enough venting area to allow rapid expansion of gases in case of fire.
- If the required temperature is not more than 200Þ F (93^{X} C), a conventional hot water heater can be used.

- If steam is required at higher temperatures, hot water heaters may be equipped with superheaters, or a steam boiler may be installed.
- High temperature boilers or equipment should be located at intraline distance from operating buildings but in no case less than 50 feet.

8.13.2. Premix Operations:

- Layout the premix buildings and the premix operating procedure so that there is no chance that nitroglycerin buggies could collide with each other. When these buggies must be left standing alone (as on elevators), block the wheels. They must be located outside the normal path of the operators except when the nitroglycerin is being discharged into the tank.
- Where premix tanks are set in at floor level, there must be toeboards of nonsparking material (preferably of metal) and an elevated handgrab rail. This is to prevent operators from slipping into the tank.
- Allow only one nitroglycerin buggy in the premix building at one time. To distribute the nitroglycerin evenly into the nitrocellulose slurry, there must be a trough of nonsparking metal or other suitable method. After the nitroglycerin has been added, wipe the trough and delivery end of the hose with a cloth soaked in triacetin and kept in soda ash.
- Use a plug type, preferably rubber, discharge valve on the premix tank and so arrange it that impact on seating the plug is negligible. Use line contact rather than surface contact between the plug and seat.
- If it is necessary to pump the emulsified slurry, use a type of pump that will not pinch or overheat the nitroglycerin. (A pump equal or similar to the "Moyno" pump is satisfactory).
- Use a signal light or other positive means of communication at each premix house to show when the final mix operator is ready to receive another charge.
- Construct slurry mixing and holding tanks of nonsparking material. Agitators must be driven by oil, air, or a remotely driven shaft. They must have enough clearance so they do not touch the bottom or sides of the tank.

8.13.3. Final Mix and Wringing:

- Weigh and prepare chemical agents added in the final mix tank in a separate room. Add the chemicals gently, preferably by means of a nonsparking chute. Screen all chemical agents to remove any foreign material before they are added. The screen will be 30 mesh or less.
- Construct wringer plows and discharge chutes beneath the wringers of nonsparking material. Use paddles of wood or other soft nonsparking material to scrape down the sides of the chutes.
- Construct containers receiving material from the wringers of nonsparking material. These containers should be covered during transportation of material to the next operation.
- If the water obtained from the wringers is recirculated back to the premix tank, use a pump such as listed above.

8.13.4. Screening:

- If nitroglycerin-nitrocellulose slurry paste is screened to break up lumps, construct the hopper and screening equipment of nonsparking metal. If lump breakers are included in the equipment, there must be enough clearance so that stationary parts do not touch moving parts. This also applies to worm feeds used to push the paste through the screen.

- Caution operators not to strike containers to loosen paste being emptied. They must use scoops or scraping paddles of nonsparking material.

8.13.5. Rolling:

- In future construction of roll buildings, separate operating and service storage bays by a reinforced concrete wall at least 12 inches thick. Exterior walls and roofs of the bays will be of light construction to afford adequate venting areas in the event of a detonation. Feed differential rolls by remote control with shielding for the operator's protection.
- In existing construction, strengthen interior walls of differential roll bays with a lining of 1/4-inch thick steel plate or equivalent. The seams of the lining should be welded. The walls should be strongly anchored to resist overturning in the event of an explosion. Existing plants should be modified to provide remote control feeding of differential rolls.
- Where operations are done by remote control, provide the operator with a protective wall as strong as the strongest wall of the operating bay.
- Where remote control is not used, provide a wooden tool at the differential rolls to allow operators to smooth out paste evenly on the rolls. This is to eliminate the danger of crushing injuries to the hands.
- Do not roll finely divided rework propellant unless extreme conditions warrant such action. In that case, rework propellant will contain not less than 25 percent of water by weight before it is placed on the rolls. Introduce rework propellant to the rolls by remote control and preheat it to a temperature of about 90Þ F before rolling.
- Design rolls so that accumulation of paste, finely divided propellant, or nitroglycerin in inaccessible places will be minimized.
- Provide a separate room to weigh into individual containers an increment of paste sufficient to form one sheet of propellant. In roll rooms, allow no more paste or sheet propellant than that required to form two sheets.
- Provide a separation room for the tanks which supply hot water or steam to operating equipment. Provide temperature control devices at the sources of hot water and steam to hold rolling temperatures relatively constant.
- Provide differential and even-speed rolls with special quick acting deluge systems of approved design. Mount deluge heads and detecting devices directly over and as close to the rolls as operations will allow. Mount additional deluge heads over the pan, tray, or conveyor designed to receive the sheet cut from the rolls. Also provide deluge heads over the paths which operators take when leaving the roll rooms in an emergency.
- Provide foot pedals or other easily reached devices which, when tripped, will quickly stop differential and even-speed rolls. If foot pedals are used, they should be in the form of a bar extending the length of the rolls.
- Provide automatic conveyors beneath the differential rolls to carry the propellant sheet away from the rolls as soon as cut. (There is a danger of spontaneous ignition of freshly cut sheets.) The conveyor should be interlocked with the knife on the rolls so that the conveyor cannot be started until the knife is engaged. The conveyor will incorporate a forced air draft cooling system.

- Perform the cutting of the sheet from the differential rolls by remote control from behind a fire retardant partition. The paste increments awaiting rolling also should be kept behind the partition. Allow no more than two increments at this location at any one time. Where the increments are fed to the rolls by remote control, an increment is allowed within the roll room while another is being rolled.
- Provide a drain trough of nonsparking material in each room to aid cleaning and to allow drainage after the deluge system has been activated. If the trough runs through two or more rooms, provide baffles in the trough at each wall. This is to prevent fragments of sheet propellant washing through adjacent rooms. Run the drain troughs into a catch box or sump outside of the building. Equip the catch box or sump with baffles.
- In rooms where operations are done before the even-speed rolling operation, hot water jacket inspection and work tables so that cold and hard sheets are not introduced to the even-speed rolls.
- Do not allow finished sheets to accumulate in any room where operations are being done. Place the sheets in a separate room pending transfer to the next operation.
- Do not stack sheets on heated tables to a height that would prevent ventilation and might allow ignition. A limit of three sheets in thickness is recommended if the temperature of the sheets is above 150^{x}F (66^{x} C).
- Rolling operations may require the presence of an operator at the rolls during operations. Thorough training of roll operators is of extreme importance. Additional safety items which will be stressed to these personnel include:
- Keeping rolls scrupulously clean and free of foreign material.
- Keeping hands away from the bite of the rolls at all times.
- Never pulling sheets from rolls. Allow sheets to fall freely to the tray after they are cut.
- Wearing protective clothing at all times.
- Not permitting personnel to go into differential roll rooms while the sheet is being cut.
- Where conveyors are not provided beneath rolls, ensuring operators wait for a specific cooling period before handling the propellant sheet.
- Not carrying newly rolled sheets in the arms. Use a tray provided for the purpose.
- Instructing even- speed roll operators in the proper method of folding sheets to prevent the formation of air pockets.

8.13.6. Forced Air Drying and Annealing:

- Where the sheet is dried after preliminary rolling and where finished grains are heat treated for castellating, drilling, and so forth, separate buildings should be provided for the heating stages. The source of heated air will be in a separate room. Do not recirculate air furnished to the drying rooms. Accurate instruments showing the temperatures inside the room should be provided on the outside of the drying room.
- Drying rooms must be free from spark-producing metals. Rooms lined with light sheet metal with welded seams should have the metal lining painted. Door hinges should be of wood construction. Wooden bar locks are recommended for doors leading into drying rooms.

- Where there is a risk of locking personnel inside a drying room, there must be an opening through the walls of the rooms at floor level. This opening must be closed with a nonsparking screen that can be easily kicked out or removed from the inside of the room.
- Rooms used for paste drying must be designed to facilitate complete washing down. Make provisions for the safe disposal of contaminated wash water.
- Dry paste is extremely sensitive to friction and impact. Moisten paste slightly before removal from the drying room. Stack paste containers only one tier high during drying and later transportation of the containers.

8.13.7. Carpet Rolling and Slitting:

- Provide separate rooms for each of the following: rest storage for incoming sheets, slitting operation, carpet rolling, and rest storage for outgoing propellant.
- Protect the slitting machine with quick-action deluge heads and equip with guards to prevent injury to the operator's hands. Provide the cutting machine with a quick- action brake, preferably activated by a foot pedal extending the length of the machine.
- If a cutting device of sparking metal is used, the bed of the machine will be of nonsparking material. As an added precaution, the table or trough from which the sheets are fed into the slitting machine will be hot water jacketed. Slit sheets will either fall into a wall box servicing the carpet rolling room or pass directly through a slit in the wall to the next room.
- If the latter method is used, a guillotine-type sliding door will be suspended over the wall opening. This is to serve as a firebreak between the two rooms. Interlock the guillotine with deluge systems in the slitting and carpet roll rooms which is activated by a fire in either room.
- Provide a tool of nonsparking material for periodically cleaning the slitting machine. The tool will be long enough so that the machine can be cleared without endangering the hands.
- Pay particular attention to ventilation for carpet roll and slitting operations.

8.13.8. Extrusion Pressing:

- The hazards of this operation require it to be housed in a building of special construction. The layout and operation will be such that the operators are not in line with the long axis of the press ram. The wall toward which the die of the press is aimed should be of light construction and should face an unoccupied area or approved barricade.
- Personnel will not be allowed in or alongside the pressroom while the press is in operation. Entrance to the pressroom will be from the outside of the building. Provide a gate controlling entrance to the pressroom. Interlock the operation of the gate with the press ram control so the ram will not travel with the gate open. The ram control will activate signal lights at the gate and in the press control room to show all personnel when the press is in operation.
- All electric motors should be in rooms separated from the pressroom.
- The press house must have a service storage room for powder in carpet roll form. This room should be separated from the pressroom by a reinforced concrete wall at least 24 inches thick. Both faces will be reinforced with rods at least 1/2 inch in diameter, spaced not more than 12 inches on centers horizontally and vertically. Stagger rods on one face with regard to rods on the opposite face and ensure the rods are about 2 inches from each face.

- Operators will be trained to remove propellant "skin" from the ramhead and the interior of the cylinder. Operators also will ascertain that the vacuum outlet from the press is free from obstruction before each extrusion.
- Periodically operators will dismantle and clean out the vacuum line from the press with a solution that will decompose nitroglycerin.

8.13.9. Castellating, Milling, and Drilling:

- Install each major piece of equipment used to do these operations in a separate room. Operate the equipment by remote control from behind a noncombustible wall. This wall must be strong enough to protect operators from an incident involving all powder within the operating room. Interlock doors to the operating room with the machine so the machine cannot be operated while the door is open. The doors will have small vision ports of safety glass (or comparable material) at least 1/4 inch thick, so the operator can view the operation in safety. Direct line of sight is not allowed.
- Provide an exhaust system on each machine for collecting chips made by cutting tools. Each room must have individual wet collectors. Chips will be emptied from collectors as needed to prevent excessive accumulations and at least once each operating shift. Keep a log on all cleaning and maintenance operations done on collectors.
- Keep cutting tools sharp and ensure they are checked daily. Dull cutting tools will only be dressed by qualified personnel.

8.13.10. Trimming. Equipment for trimming the ends of grains will comply with the requirements listed above. Collect the trimmed cross sections in water.

8.13.11. X-Ray Inspection. Perform all x-ray inspections according to TO 33B-1-1, Non-Destructive Inspection Methods.

8.13.12. Inhibiting:

- Keep solvents for applying inhibitors or propellant in approved safety cans. Allow only the minimum quantity of solvent needed to operate efficiently in operating rooms. Quantities required for 4 hours continuing operation are the maximum allowed.
- Install exhaust systems at inhibiting operations to keep the solvent vapor concentrations in the rooms within safe limits (AFOSH Standard 91- 2, *Vehicle-Mounted Elevating and Rotating Work Platforms, Manually-Propelled and Self- Propelled Mobile Work Platforms, and Scaffolds (Towers)*). If exhaust systems are connected to a main duct servicing several rooms, install spark arrestors in the exhaust line from each room. This is not needed if the concentrations of vapor are known to be outside the flammable range at all times.
- Wall Boxes. Use wall boxes liberally for transferring propellant sheets or grains between rooms of the same building. Construct the wall boxes of fire-resistant and non-sparking material. They will close to furnish an effective firebreak, but the boxes will be designed to vent a fire within the box. Do not vent wall boxes toward normal work positions of operators.

8.13.13. Handling and Transporting:

- Cover paste, sheet-propellant carpet rolls, and extruded grain during transit between operations.
- Stack sacks or other containers of dry paste only one high during transportation and storage.

- See paragraph 2.71 of this supplement for materials handling equipment operational and safety requirements. Compliance is considered especially important in connection with these explo sives.
- During cold weather, consider transporting explosives in hot water jacketed containers to prevent excessive hardening or freezing of the explosives.

8.13.14. Housekeeping:

- Set up schedules for periodic cleaning of buildings and observe strictly. These schedules should include dismantling of equipment and cleaning with a solution that will decompose nitroglycerin.
- Use a 50-50 mixture by weight of the following solutions to decompose small quantities of nitroglycerin:
- Solution A. Nine parts sodium sulfide (pulverized) and thirty parts water, by weight.
- Solution B. Seventy parts denatured ethyl alcohol and twenty parts acetone, by weight.
- Do not combine these two solutions until immediately before destroying the nitroglycerin because the mixture potency diminishes in storage. Limit the use of this mixture to small quantities of nitroglycerin. For example, the oily film that adheres to surfaces after the nitroglycerin has been removed with sponges or absorbed in wood pulp or sawdust. Operators using this solution must wear rubber gloves and eye protection.
- Place wood pulp, sawdust, and other material contaminated with nitroglycerin in a special container used only for this purpose. It will be transferred to the burning ground at the close of each cleaning operation.

8.14. Military Pyrotechnics:

8.14.1. Weighing Raw Materials:

- When weighing explosives or highly combustible materials, use scales which are electrically grounded. The ground current-carrying capacity must not be less than a No. 8 (0.128 inch) copper wire.
- Two separate weight or measure rooms must be used: one for oxidizing agents and one for combustible material and metallic powders. Vessels, sieves, and other pieces of equipment used for oxidizing agents will not be used for combustible materials and metallic powders (or vice versa). This equipment should be marked to show the type of material with which they are to be used.

8.14.2. Drying of Materials:

- Apply heat by the indirect method whereby air is blown or drawn over radiators and circulated through the mass of materials to be dried. Do not re-circulate air which has passed over the material being dried over the heating coil.
- Find the safe temperature for drying each material. Do not exceed this temperature at any point in the dryer apparatus or drying room.
- Use thermostatic control to maintain the maximum temperature in the drying apparatus or dryer room and record it at regular intervals. Install a temperature indicator-recorder to keep a continuous and permanent record. Put it where it will indicate the maximum temperature, such as the drying room or dryer apparatus.

- Use nonferrous metal trays for spreading material for drying and electrically ground the trays.
- Hold dust formation or accumulation to a minimum.
- To prevent overheating, use the following or a similar procedure to control the oxidation rate of linseed-oil-coated magnesium powder: spread the magnesium powder in properly grounded nonferrous metal trays to a depth of not more than 2 inches. Keep the humidity between 50 and 55 percent, and the room temperature below 8^{x} F. Air conditioning equipped with a reheat system is necessary to ensure these conditions.

8.14.3. Mixing and Blending of Components:

- Blending should be done in a building used only for this purpose. Multiple blending of pyrotechnic mixtures or explosives may be done in the same building. However, each blender or mixer must be located in a separate room (or cubicle) separated by a substantial dividing wall.
- At least one wall or equivalent panel area in more than one wall will be of weak construction. No one will be allowed to pass in front of the weak wall or panel area while the blender is in operation.
- All operating controls will be placed outside the cubicle and they will be protected by a substantial dividing wall located at intraline distance from the blending cubicle.
- Driving belts will be only allowed inside the blending rooms when steps have been taken to ground for static electricity.
- When blending or mixing is done in bays, such bays will be of a construction suitable for the hazards of the material being processed. The walls of each bay should extend at least 24 inches above the roof. The roof over each bay should be independently supported and of freelift type.
- Strong oxidizing agents, such as peroxides, chlorates, and perchlorates, cannot be desensitized with oil or other similar fuels. When oxidizing agents are blended with fuels, use a mechanical blender operated and installed as prescribed in this paragraph.
- Blending or mixing machines will not be used with rotating blades in mixing hazardous materials. Mixers which use the mulling principle, such as the Simpson Intensive Mixer, are allowed. The preferred type of machine may be described as a burnishing barrel (capable of being elevated, depressed, and emptied from behind a barricade).
- If the blender is equipped with metal baffles, the baffles must be welded in position.
- Balls or similar blending aids will not be used in blenders or mixers equipped with baffles unless the balls can move freely between the base of the mixer and the baffles.
- Blenders will be operated by a shaft extending through the building wall and connected to a motor located outside the blending bay.
- The blender will be electrically grounded.
- Blenders will be provided with a safety seal or other suitable method of relieving any excessive gas pressures developed within.
- The quantities of composition per charge must not exceed the amount of explosives consistent with continuous operation. The quantities in Table 8.2 below should be considered allowable for blending at any one time in one room. They are based on quantities normally required for continuous safe operation.

Table 8.2. Suggested Quantities per Charge for Blenders.

Material	Quantity (pounds)
Igniter composition for tracer	50
First- fire composition	50
Tracer composition	50
Flare, signal or incendiary composition	100
Magnesium powder coating	100
Thermite	200

8.14.4. Pressing, Loading, and Pelleting:

- Perform pressing operations only on approved types of presses. Protect personnel by an effective barricade or shield.
- Before repairing, adjusting, or clearing a jammed press, remove the explosives from the hopper and the bay or pressroom.
- Allow only the quantity of composition required for the pressing operation behind the barricade at any one time. Not more than the quantity needed to meet established production schedules may be kept in the rest of the pressroom at any one time.
- If the composition before pressing is subject to ignition by spark, cover benches and floors with conductive nonsparking material and ground them electrically (Section D). In such locations, personnel will be equipped with conductive-sole shoes.
- Locate each press or loading machine for pressing or loading operations in a separate building, room, or cubicle. The walls should extend above the roof or be otherwise suitably barricaded to protect the operations, depending on the quantity and type of material. Building exits should be installed directly to the rear of the operator's normal working position. All motivating equipment (such as hydraulic pumps and motors) will be exterior to the pressroom. At least one wall or equivalent panel area in more than one wall of the press or loading room will be of weak construction.
- Each press must be electrically grounded.

8.14.5. Assembly:

- Perform matching and igniter assembly in a separate room or building.
- Separate individual assembly operations from each other to avoid congested conditions and crowding of employees.
- Place benches with ends toward the exits to provide ready exit in case of emergency.
- Maintain a continuous flow of completed items from the assembly room to storage. Only the minimum amount of components needed to maintain the production schedule may be kept in any assembly room.
- Do not allow components or assembled items to accumulate in aisles or in front of exits.

8.14.6. Grinding:

- Grinding equipment will have all metal parts electrically bonded, and the entire group of equipment items should be electrically grounded.

- In operating ball or hammer mills, the operator will be protected from the effects of a fire or explosion occurring within the mill. Use intervening dividing walls or operational shields of suitable design and strength.

8.14.7. Screening:

- Screening is done to remove extraneous materials and to obtain uniform granulation of constituents. Screening may present a toxic, fire, or explosion hazard.
- All power-driven screening equipment will be equipped with dust-tight enclosures to reduce the escape of dust from such equipment. The enclosures should be designed to prevent sparks due to impact between two spark-producing materials.
- All screening equipment will be electrically grounded.
- Mechanically operated screening equipment is preferred to manually operated equipment. Where screening is done by hand, provide ventilating hoods if the dust concentration exceeds the criteria established in applicable TOs. Build these hoods so that operators cannot breathe the dust. When operators are hand screening chlorates or similar materials, they must wear gloves.
- After the screening operation is completed, all materials will be placed in suitable covered containers.

8.14.8. Painting and Marking. All spraying operations involving flammable liquids will be segregated and done in spray booths built according to NFC, Standard 33, Spray Application.

8.14.9. Reworking:

- If required to be repaired and reassembled, process defective-loaded components in a building where no other operations take place. Separate such buildings by appropriate intraline distance from other buildings of the plant.
- Rework defective- loaded components only under the supervision and direction of personnel fully aware of the hazards involved in assembly and disassembly operations.
- Do not pulverize consolidated mechanical pyromixtures for reblending operations.
- Do not rework consolidated pyrocomposition not complying with specifications as to candlepower and burning time.

8.14.10. Housekeeping. Cleaning will be done as local circumstances require for maintaining safe conditions. Do not perform general cleaning while operations are in progress.

8.14.11. Maintenance and Repairs. Only qualified workers may make repairs to operating buildings, storage magazines, service magazines, or equipment. Before any repairs are started, inspect the surrounding area for pyrotechnic materials. Remove all traces of such materials.

8.15. Chlorates:

8.15.1. General Information. Chlorates mixed with sulfur, sulfides, or other readily oxidizable material may result in spontaneous ignition. Sulfur is a greater hazard than sulfides. The addition of phosphorus to a sulfur and chlorate mixture makes an even more dangerous composition.

- Shellac, potassium, or sodium nitrate with petroleum derivatives, and powdered metals render chlorates sensitive. Mixtures of trinitrocresol or picric acid and chlorates should be avoided

since they are particularly sensitive. Chlorates should never be mixed with ammonium salts since ammonium chlorate may explode spontaneously.

- Any chlorate mixture that contains 0.5 percent or more of moisture is hazardous because it may form chloric acid.

8.15.2. In any of the mixtures described above, the substitution of sodium chlorate for potassium chlorate increases the hazard.

- Ammonium Chlorate. Ammonium chlorate decomposes spontaneously and, when mixed with perchlorates, constitutes a major hazard.
- Barium Chlorate. Barium chlorate is very toxic on contact with the skin, when inhaled as a dust, and when ingested. Barium chlorate is more dangerous than potassium chlorate for storage.
- Zinc Chlorate. Zinc chlorate when in contact with certain organic materials will explode under slight friction, percussion, or shock.
- Containers. Containers for shipping and packing chlorates will be nonabsorbent and noncombustible.
- Storage. Chlorates should be stored so they do not touch any other combustible (organic or inorganic) material. Broken or damaged containers should be removed and spilled material swept up promptly.
- ires Involving Chlorates. Fires involving chlorates should be fought with solid streams of water or with water fog, depending on the circumstances:
- The use of solid streams enables fighting the fire from a greater distance but introduces the possibility of steam explosion.
- Water fog offers the advantage of quicker cooling. However, its normal smothering action is useless since the chlorates furnish oxygen to the fire.

Warning: Latent fire hazards may be generated in any material (shoes, clothing, etc.) that becomes saturated with chlorate- laden water from fire fighting. Contaminated clothing and other materials must be removed promptly and decontaminated or disposed of. When they dry out, these materials are easily ignited and are serious fire hazards.

8.16. Perchlorates:

8.16.1. General Information. Perchlorates form slightly less sensitive mixtures than do chlorates and, when possible, should be substituted for them. Percholrates are less sensitive to impact and friction and do not form a free acid when moisture is present. They are less hazardous if they come in accidental contact with weak acids.

- Ammonium Perchlorate. Ammonium perchlorate alone is an explosive but is exploded with difficulty. It is stable at ordinary temperatures but decomposes at a maintained temperature of 302^{X} F (150^{X}C). It has the same degree of sensitivity to impact as picric acid. It becomes a high explosive when mixed with flammable materials and metal powders.
- Containers. Containers for perchlorates in storage include wooden boxes, kegs, barrels, and sometimes iron drums. All damaged and broken containers should be removed from the storehouse and spilled material swept up promptly and destroyed.
- Fires Involving Perchlorates. Fires involving perchlorates alone may be fought with water.

8.17. Peroxides:

8.17.1. General Information. Solid peroxides should be stored in a cool, dry place because they decompose easily in the presence of moisture and liberate oxygen. Consequently, they are a dangerous fire hazard, particularly when mixed with combustible materials. Sodium peroxide should be protected from contact with water since it then becomes explosive. Hydrogen peroxide of about 30 percent strength is unstable, liberates oxygen, and exhibits much the same characteristics as the solid peroxides.

8.17.1.1. High Strength Hydrogen Peroxide. (See AFM 161- 30,V2, *Liquid Propellants*.)

- High strength hydrogen peroxide (90 percent or greater) is shipped in specially designed containers which are vented. It should be stored only in containers which are vented to the atmosphere and the vent constructed so that foreign material will not enter containers. It must be stored in a cool, shaded location used exclusively for that purpose.
- Control the temperature of containers of hydrogen peroxide. Hydrogen peroxide decomposition is a function of temperature.
- Instruct operators to report any undue heating of hydrogen peroxide drums to the person in charge and evacuate the area immediately. Install a water-spray system for cooling in hydrogen peroxide storage locations. It will be turned on immediately when any undue heating of the storage drums is observed.
- If hydrogen peroxide is to be stored for long periods, use high purity aluminum containers.
- All tanks, tubes, and fittings must be cleaned thoroughly. The following is a recommended cleaning procedure:
- Place parts in a pickling solution of 0.5 percent sodium hydroxide for 1 hour at room temperature.
- Wash with clean water, dry, and place in a 35 percent solution of chemically pured (CP) sulfuric acid for 1 hour at room temperature.
- Wash, dry, and place in a 25 to 30-percent solution of hydrogen peroxide for at least 24 hours, then drain off and discard the solution. The part is then ready for use.
- When hydrogen peroxide touches the skin, it causes a burn and discoloration. Running water should be available in the storage area. Any part of the skin that has contact with hydrogen peroxide should be washed immediately with water. A 3-percent boric acid solution should be available for irrigation of the eye in case of accidental splashing. Spills of hydrogen peroxide must be immediately washed away with water. All persons handling this material will wear face shields, rubber gloves, and rubber trousers on the outside of rubber boots.
- Only the following materials should be used in equipment contacting high strength hydrogen peroxide: "Pyrex" glass, high purity aluminum, pure tin, "Koroseal," or equal. Stainless steel types 304, 309, 310, 316, 321, and 347 are suitable for periods of 2 months or less.
- Fires Involving Peroxides. Fires involving peroxides, except sodium peroxide, may be fought with water. Sodium peroxide fires should be smothered with sand, ashes, dirt, or rock dust.

8.18. Nitrates:

8.18.1. General Information. Nitrates not flammable in themselves are usually stored in wooden boxes, kegs, or barrels. Ammonium nitrate, however, is usually shipped in special waterproofed bags or metal containers. Barium nitrate is sometimes stored in iron drums. Regardless of the type of container, it should be moisture-proof. Nitrates should be stored in a dry place since they cake in the presence of moisture.

8.18.1.1. Ammonium Nitrate:

- When confined, ammonium nitrate may detonate with the violence of a high explosive, but a relatively heavy initiator is ordinarily required. Under the effect of heating alone, ammonium nitrate will decompose. Contamination with chlorides, sulfur, nitrobodies, charcoal, metallic nitrates, metal powders, petroleum derivatives, and oxidizable carbonaceous materials sensitizes ammonium nitrate. It also accelerates decomposition and increases the violence of the reactions.
- Zinc or lead contamination lowers the decomposition temperature to 200_ symbol 176 "Symbol"__ F (93.3^{x} C). Do not use any galvanized metals or lead solder near an ammonium nitrate operation.
- The burning of ammonium nitrate and combustible materials, such as wood or paper containers, may produce a mixture of gases. This gas mixture may, under pressure, explode with enough force to detonate the ammonium nitrate. Fires involving ammonium nitrate will be vented to the greatest practical extent. Air acts as a diluent for the hazardous gases and reduces the risk of an explosion.
- In high pan (evaporating) operations, deluge systems will be provided over the pans for use in case of fire. Temperatures used to heat ammonium nitrate will not exceed 317^{x} F (158^{x} C). High pan operations will be located at class/division 1.1 distances (K18) from adjacent structures other than the graining building. The graining building, however, will be protected from the high pans by an approved barricade. The K18 distances may be based on the maximum quantity of ammonium nitrate contained in any one high pan.
- Fires involving nitrate should be fought with large quantities of water but never with steam. The fire can be fought from a greater distance with solid hose streams. However, if the nitrate is molten, there is a hazard of steam explosion. Therefore, the hose streams should be directed from behind a protective barrier. If the fire is in the incipient stage and accessible, water fog may be used to advantage in some cases. Fog has no smothering action since the burning material provides its own oxygen.
- Storage of ammonium nitrate in explosives storage magazines is preferred. When stored in an area where explosives may be projected into the nitrates, comply with requirements for class/division 1.1. When stored in an area with fire hazards only, ammonium nitrate may be stored as a class/division 1.3 solid propellant. In this case, it must be separated by inhabited building distance from areas containing ammunition.
- Ammonium nitrate should be stored in buildings easily vented in case of fire so that the gases produced during combustion are dissipated. This does not apply to earth-covered magazines. The floors of such buildings should be of a type that prevents hazardous impregnation by the nitrate.

- Stacking within storage buildings, other than in earth-covered magazines, should be limited to stacks not larger than 12 feet by 12 feet and not higher than 7 feet. Aisles at least 3 feet wide should be maintained around each stack and between the stack and the sides of the buildings. The use of wood dunnage should be held to a minimum.
- Broken packages or containers will be removed from the building and the spilled material swept up promptly and destroyed.

8.19. Powdered Metals -- Aluminum, Magnesium, and Aluminum Magnesium Alloys:

8.19.1. General Information. When compounded with oxidizing agents, powdered metals present a dangerous fire and explosion hazard.

- Ventilation. When metal powders come in contact with water, their temperature rises, and they may ignite. Therefore, all practicable precautions should be taken to prevent any water from touching the material. All buildings where powdered metals are stored or processed will be adequately vented at the highest point of the room or building (AFOSH Standard 91-2). This is so that hydrogen gas, which forms when powdered metals react with moisture, cannot accumulate.
- Temperature and Humidity Control. Exposed material at a low temperature should be brought to, or near, room temperature with low relative humidity before being placed in the operating room. Approved heating facilities should be installed in service magazines to bring the closed containers and contents to a temperature near that of operating buildings. The relative humidity should be between 50 and 65 percent in any location where metal powders are exposed. This is to avoid the hazard of static electricity and prevent condensation. Humidity can best be controlled through use of air conditioning equipped with a reheat system.
- Storage. Powdered metals in metal containers with tight covers may be stored in a general warehouse if they are remote from oxidizing agents. The storage place should be dry. Locate pipes where condensation on them cannot drip on hazardous material and where any leaking pipes cannot cause ignition.
- Handling. Operators should wear sweat bands on their foreheads and take other precautions to avoid perspiration falling on powdered metals.
- Static Electricity. Very fine suspended dust from powdered metals is an explosive hazard comparable to that of explosive gases. It may be easily initiated by static electricity.
- Fires Involving Powdered Metals. If powdered metals are exposed to air, they are dangerous fire hazards because they burn with intense heat. When in drums, the fire will probably confine itself to the place of origin if not disturbed. In this case, it will be effectively blanketed by the metallic oxide formed by the burning.
- Do not fight these fires with streams of water because they may release large quantities of hydrogen gas which can be a severe explosive hazard.
- Fires involving small quantities of powdered metals may be successfully fought with a fog nozzle. Specially designed commercial extinguishing powders may also be applied gently, so the fire does not spread. Fire may also be smothered with dry sand or dry powder fire extinguishers.
- If large quantities of powdered metals are involved in a fire outside their storage containers, fire fighting should be primarily to prevent spread to other facilities. In locations where fric-

tion sensitivity is not another risk, fires may be smothered with sand or use a dry powder fire extinguisher.

- Personal Protective Equipment. Provide proper personal protective equipment for personnel handling powdered metals.
- Repairs to Buildings and Equipment. Only competent personnel should be allowed to repair or maintain buildings or equipment where metallic powders are involved. The following precautions must be taken: remove powder or dust, use nonsparking tools, avoid hammer impacts that may cause sparks, use flashlights of an approved type, make sure the equipment is grounded, prevent undue friction, and do not use open flames. (See the NFC, Standard 63, Industrial Plants, Dust Explosion.)

8.20. Charcoal. Charcoal may ignite spontaneously in the presence of moisture. Pit charcoal is less likely to react than its chemical byproduct charcoal. Soft wood charcoal is less likely to ignite than hardwood charcoal.

- Forced cooling after burning, drying after absorbing moisture, contact with alcohol's and oils, and particularly a charcoal fire that has been extinguished promote spontaneous ignition of charcoal. Pulverized charcoal is also a fire hazard.
- The gases from burning charcoal contain carbon monoxide and are toxic.
- Permanent or reserve storage of large quantities of charcoal is not recommended. Bulk storage of charcoal is prohibited. It should be stored in air-tight containers or in bags piled in tiers, with skeleton or gridwork floors between the tiers to provide ventilation. It should be isolated from oxidizing agents.

8.21. Sulfur. Sulfur compounded with chlorates and several other oxidizing agents forms highly sensitive explosive mixtures.

- When sulfur is mixed with carbon, lamp black, fats, and oils, it may ignite spontaneously. Burning sulfur produces toxic vapors.
- Sulfur may be stored in wooden boxes, kegs, or barrels. Large quantities may be stored in bulk. It should be isolated and remote from oxidizing agents with which it forms highly sensitive explosive mixtures.

8.22. Volatile Flammable Liquids. Examples of common volatile flammable liquids are ether, acetone, gasoline, ethyl alcohol, methyl alcohol (wood alcohol), benzene, toluene, xylene, and amyl acetate.

- These liquids are volatile. If unconfined at room temperature, they may evolve vapor in concentrations in air within the explosive range.
- Volatile flammable liquids must not be used to wash or clean equipment or parts of buildings, except where specifically authorized as a process requirement.
- Some flammable liquids (such as linseed oil, paints, varnishes, and enamels) may ignite spontaneously under certain conditions. They must be kept where any heat produced will readily dissipate. They must also be kept away from any outside source of heat.
- Only noncombustible sweeping compounds must be used in cleaning up materials of this type.

8.23. Calcium Carbide. Small quantities of calcium carbide may be stored in airtight tin cans or iron drums in a general warehouse. Large quantities must be stored in a separate building of noncombustible construction or a detached weatherproof shed. The storage place should be dry and well ventilated. Spe-

cial precautions should be taken against moisture. Calcium carbide is a slight fire hazard. However, it reacts violently with water to liberate large quantities of acetylene gas, which forms explosive mixtures with air.

8.24. Nitrocellulose and Derivatives. Nitrocellulose includes various types of nitrated cotton or wood pulp, depending on the nitrogen content.

- Dry nitrocellulose is extremely sensitive to shock and friction and readily accumulates static charges. It is highly flammable and explosive, burns rapidly, produces little smoke, and leaves no residue. If it is impure, it may ignite spontaneously.
- Dry nitrocellulose must not be stored because it has all the hazards of a sensitive and easily ignited high explosive.
- Nitrocellulose containing 25 to 30 percent moisture is stored in zinc-lined boxes or metal drums. If it is stored in an area into which ammunition or explosives cannot be projected, it is substantially nonexplosive.

8.25. Research, Development, and Testing Operations:

8.25.1. General Information. Facilities used for research, development, and testing require special guidance and restrictions. They also need relief from certain rules prescribed here to maintain a safe and efficient operations capability.

8.26. Blast and Fragment Confinement Facilities. Make a detailed review of each operation. Make sure that the explosives limits are within the capability of the laboratory or test areas as prescribed in this supplement and AFJMAN 32-1092 (AFM 88-22,) *Structures to Resist the Effects of Accidental Explosions*. Facilities can be designed to totally confine blast and fragment hazards and eliminate the need for public traffic route and inhabited building distances. As the capability to confine fragment and blast is reduced, explosives limits and safe separation must be adjusted accordingly.

8.27. Structure Reinspection. If there is a detonation in one of the total confinement facilities described in para 8.3.1 or para 8.26 of this supplement, the facility must be inspected by a qualified engineer. The inspector must make sure that structural integrity is maintained or must reduce explosives limits so that any later blast will not exceed the retention capability of the structure.

8.28. Program and Facility Review. Each proposed program for the laboratory or test facility will be reviewed by the operational supervisor, the explosives safety officer, and the system safety office to determine all foreseeable hazards involved. This review must include:

- Structural limitations of the facility.
- Remote control viewing and operating equipment, if required.
- Special safety precautions for other personnel in the building.
- Safe separation distances.
- Deviations required from the basic AFMAN 91- 201.
- Written instructions needed to ensure safe operations, such as:
- Protective clothing required.
- Warning signals during operations.
- Fire and other emergency procedures.

- Special testing of the operating equipment needed before operations (such as stray voltage and calibration checks).
- Removal of all explosives not needed for the operation.
- Arrangements for overnight storage of explosives used in the test.
- Inspection and cleanup procedures following a test or after a detonation of the test item. Clean up instructions identify who is responsible for disposing of hazardous explosive waste and how it will be done.

8.29. Operational Approval. The laboratory commander must approve the results of the operational safety review. This must include hazard corrections and written procedures before the explosives safety officer issues a license for the operational facility. The MAJCOM determines the approval level for written procedures. Within AFMC written procedures are approved at the division level.

8.30. Operational Limitations. The quantity of explosives used in any laboratory operation will be the minimum needed to get the required results. Also, small quantities will be reduced further when new or relatively unknown explosives are being tested to find their hazard characteristics.

8.31. Incremental Safe Separation Distances. Where laboratory and test facilities cannot be properly shielded to prevent the release of fragments and blast, the following applies:

- Where facilities and roadways warrant the protection equal to that required for the general public, the minimum safe separation distance will be 1250 feet, from housing areas, schools, and on-base public roads.
- Incremental inhabited building distance of Table 3.6 will apply to operations, facilities, and personnel organic to the using organization where lesser distances do not apply under this manual.

8.32. Storage Compatibility Exceptions for Laboratory and Field Test. If the proposed storage facilities will confine the blast and fragments, or the incremental inhabited building distances are as indicated in this supplement, paragraph 8.31, the following applies:

- Up to a total of 15 pounds of explosives may be stored without consideration of storage compatibility. However, the operation must be reviewed and approved as stated in paragraph 8.28 and only applies to R&D functions and activities directly supporting R&D programs.
- The MAJCOM may authorize the storage of up to a total of 1,000 pounds of incompatible storage. Send request to HQ AFMC/SEW.
- For quantities over 1,000 pounds of incompatible storage, a request must be submitted for a deviation to HQ AFSC Kirtland AFB NM 87117-5671 through HQ AFMC WPAFB OH 45433-5006.

Attachment 1

EXPLOSIVES SITE PLAN COVER LETTER

The following is an example of what should appear in your cover letter to this HQ. It is not possible to include every type of site plan situation that could be forwarded for review, but your cover letter should approximate the categories of this attachment as closely as possible.

MEMORANDUM FOR: HQ AFMC/SEW

FROM: BOONDOCK AFB/SEW

SUBJECT: Request Review and Approval of Explosive Site Plan AFMC-BOONDOCK-00-S1

1. Subject line: The subject line must state if the site plan is to be handled expeditiously or routinely. If the site plan requires expeditious handling then follow all of the requirements of Para 4.11.3.8.1 through 4.11.3.8.6. Remember lack of planning on your organizations part is not a good reason to ask for expeditious handling. Also, AFMC/SE is required to review all expeditious request for validity and sign the cover memo.

2. Purpose: Describe the purpose of the intended operation. "Request routine processing for subject site plan, for preliminary or final approval".

3. Reason(s): State the reason(s) for the request. For instance; construct a new maintenance facility. If the site plan covers new construction provide the identification and program design and construction number (PDC) Also, at this point you might add what type construction is to be accomplished. For instance; "The facility will be of cinder block construction, with two poured concrete walls". If there are definitive drawings provide the number in the paragraph.

4. Replacement Site Plan: If the new site plan is replacing an old site plan, include the previous number, and a cancellation request.

5. Safety Criteria: State whether all explosives, environmental, health and security criteria will be met. Include in this paragraph any unique aspects of the plan, and under what criteria it will be used. If there are any compensatory measures describe them in detail. Especially if they are necessary to meet minimum QD. **NOTE:** Installation commanders must sign the reverse side of the AF Form 943, indicating they understand the compensatory measures. See Para 4.10 and 5.2.6

6. Format: Explain in the cover letter which format you are using. For instance; "the attached AF Form 943 and map show all the exposures and required separations." Also briefly describe what the ESP package contains.

7. Facility Board: Include a statement that the project has been reconciled with the comprehensive plan. Also provide a copy of the minutes showing approval by the Facility Board.

8. Other areas: Other areas that you might find appropriate for addition in your cover letter.

a. **Protective features**: List all protective features. Lightning protection, fire protection, grounding systems, dividing walls, vent walls, firewalls, exits, and any other detail that might be considered a protective feature. See 4.11.4.5 and 4.11.5.5 for additional information.

b. Special Equipment: List any special equipment that might be used in the facility. For instance; cranes, conveyors, heaters or any other type of equipment that would not be considered part of the actual facility.

c. Personnel limits: Mention the personnel limits. For explosives operating locations, include the average number of persons who will be in the facility during a normal duty day.

d. Utilities: Describe the utilities located inside the clear zone even if QD is not applied, it can bring about a clearer picture of the project. If a utility is exposed, this is the place to mention any conditions that will not cause a waiver condition.

e. EMR Hazard: Mention that an EMR hazards were evaluated. If a facility is being constructed it will probably have a radio alarm system. That should be evaluated, and included in a attachment, along with any other emitter that may be present.

f. Doors and Windows: This is the place to write about the glass breakage analysis and what is being done to mitigate potential breakage. The actual analysis can be provided as an attachment.

g. Lightning Protection: Describe the type of lightning protection that will be utilized for the facility. The actual drawings for that facility, not a typical drawing, must accompany the site plan. If the drawings do not show exactly how the system is to be installed, the site plan will probably be rejected by DDESB. See 4.11.4.5.1 for additional requirements.

h. Distance Equivalent: If a distance equivalent is claimed for a facility, a certified structural engineering analysis is required and should be added as an attachment.

I. Description: Provide a narrative description and drawings for the final site plan.

j. User: Indicate who the user is going to be. If the user is a tenant, the entire site plan must be coordi nated with that users command (other services) before it is forwarded to HQ AFMC.

k. Evaluation Zone: Mention the evaluation zone. When an evaluation zone does not exceed the IB clear zone or if the there are no PESs in an evaluation zone, state this in the cover letter

l**. Coordination:** Site plans must be coordinated with all units or organizations that are effected. If two or more units on base effect each other, there must be coordination between those units, and their parent organizations prior to forwarding the plan. A POC is not considered proof of coordination. A high level managers, or commanders must show concurrence before any plan is forwarded for consideration.

9. Siting a Nonexplosives ES. For requests to site nonexplosives ESs, the following information must be included. A detailed description of the facility to include the type of construction, function and the location and type windows. Include the user, number of personnel and any special features that may be present. See para 4.11.6.3 for additional information.

JOHN W. RUSSELL, Jr.
Acting Director of Safety